Network and encoding aspects for Cloud-based VoD Service: An experimental and SPN modeling approach

Jamilson Ramalho Dantas

jrd@cin.ufpe.br

Orientador: Prof. Paulo Maciel

Introduction and Motivation

- **Cloud computing** platforms provides **storage capacity**, **processing power** and other **computational resources** in a flexible way.

- Current **video streaming** services offer a large variety of multimedia content in **many formats**

[1] Adhikari, V.K., Guo, Y., Hao, F., Varvello, M., Hilt, V., Steiner, M., Zhang, Z.L.: Unreeling netflix: Understanding and improving multi-cdn movie delivery. In: INFOCOM, 2012 Proceedings IEEE, pp. 1620–1628. IEEE (2012)

Introduction and Motivation

- A Fact
  - Netflix was pointed out as the single largest source of Internet traffic in the United States, consuming 29.7% of peak downstream traffic [1].

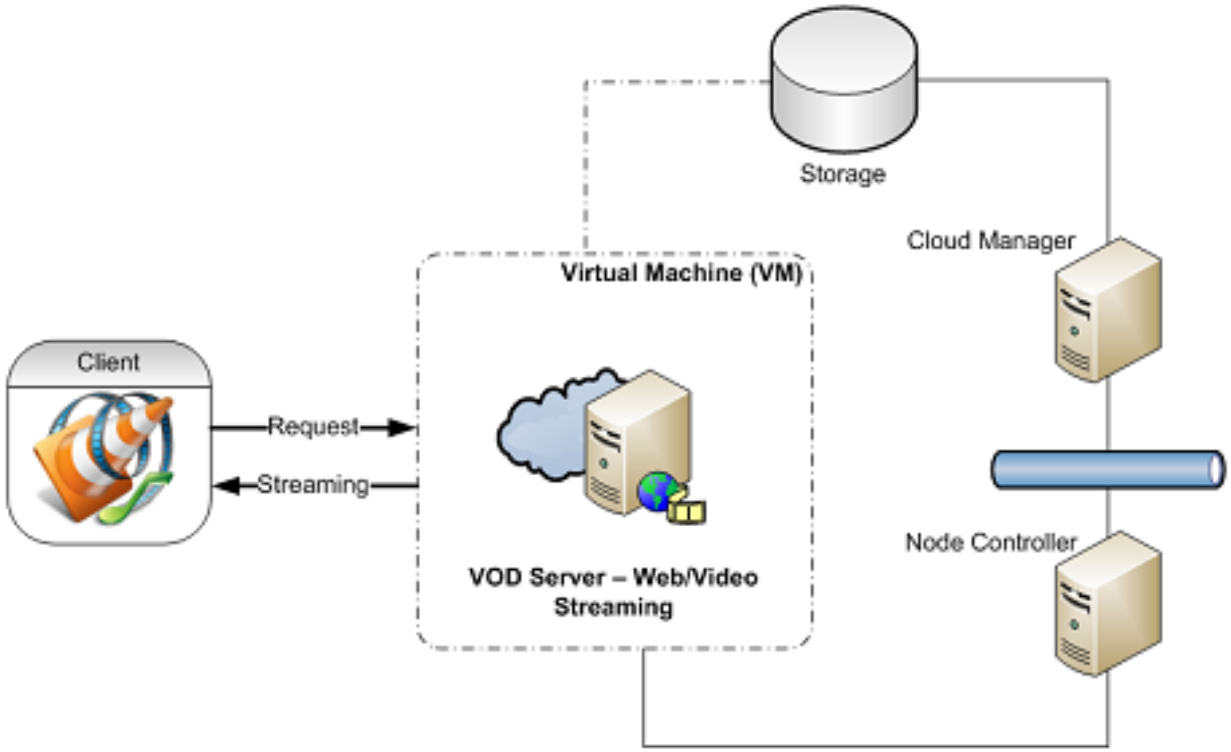
- In this context video file format and the streaming is a factor which might affect the quality of service (QoS), due to large network traffic and overloaded servers.

Objective

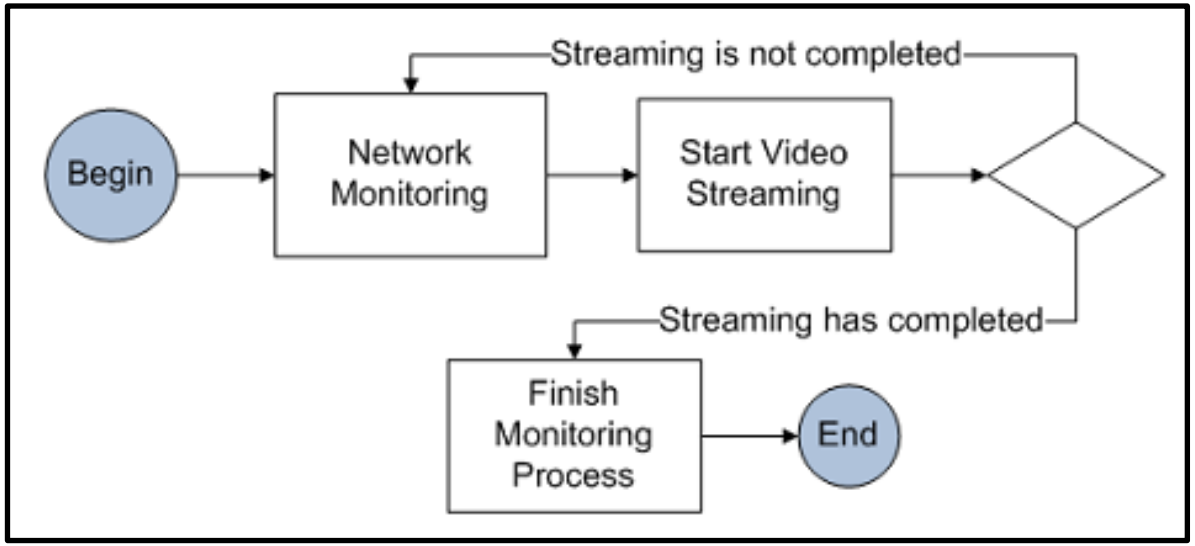
- Investigate the Quality of Service (QoS) perceived by end users that might be affected by network congestion.
  - videos in MPG, MP4, AVI and FLV formats.

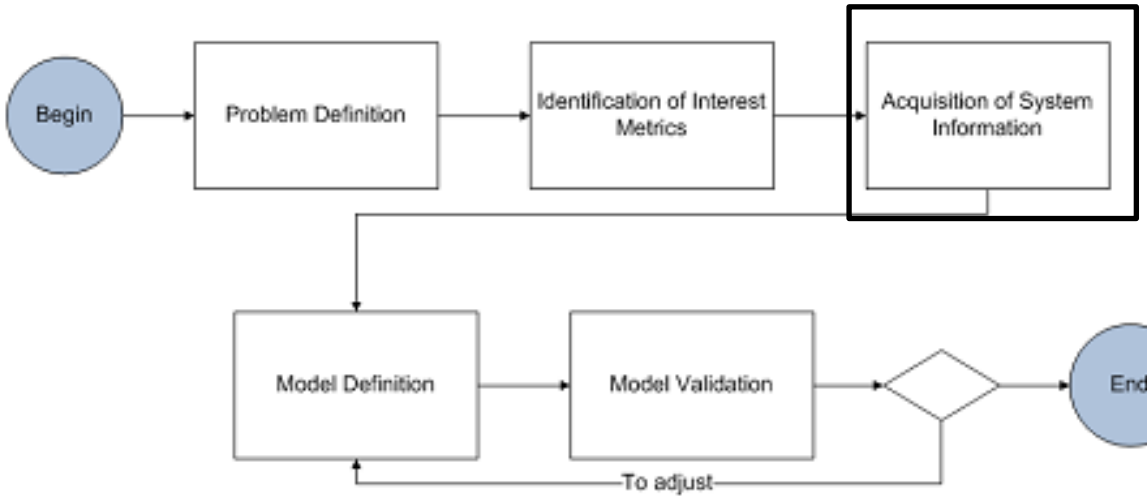
- To Provide
  - a SPN model for quantify the packet loss ratio, packets received by end users and throughput for each kind of video in a cloud-based VOD environment.

System Description and evaluation methodology



System Description and Evaluation Methodology



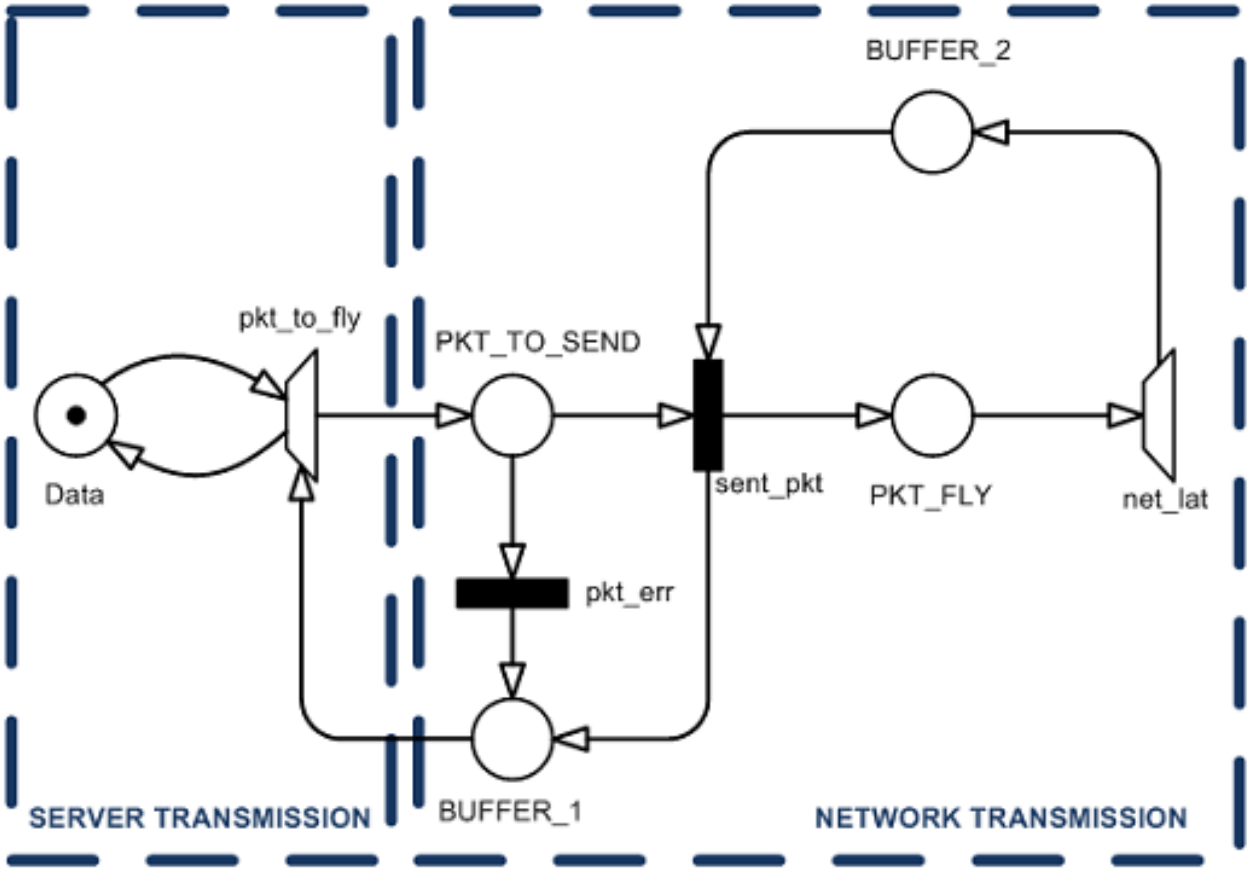


Acquisition of System Information

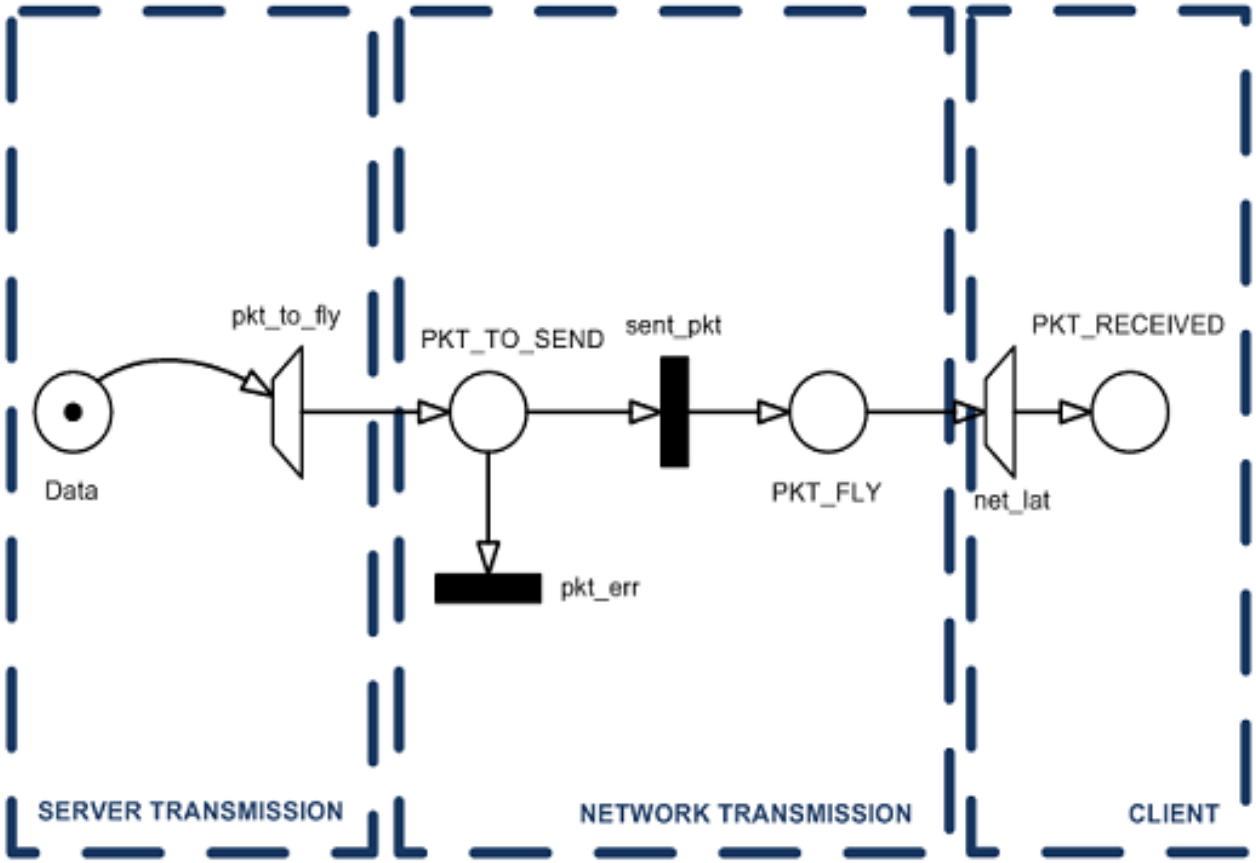
- Four video types were employed: MP4, MPG, AVI and FLV formats. Each video has a duration of five minutes, and the experiment was executed thirty times for each video.

- Metrics
  - Packets received by client
  - Packets sent by the server
  - Packets lost
  - Throughput

Performance Model



Performance Model



Performance Model

- Information assigned to Immediate Transitions

Transition	Weight		Priority	guard Function
pkt_err	MP4	0.0029	1	—
	MPG	0.0021		—
	AVI	0.0027	1	—
	FLV	0.0007	1	—
sent_pkt	MP4	0.9971	1	—
	MPG	0.9979	1	—
	AVI	0.9973	1	—
	FLV	0.9993	1	—

- Definition Delays for Timed Transitions

Transition	Delay (ms)	
pkt_to_fly	MP4	5.691
	MPG	6.802
	AVI	5.860
	FLV	5.727
pkt_rec	MP4	5.565
	MPG	6.752
	AVI	5.751
	FLV	5.619

Performance Model

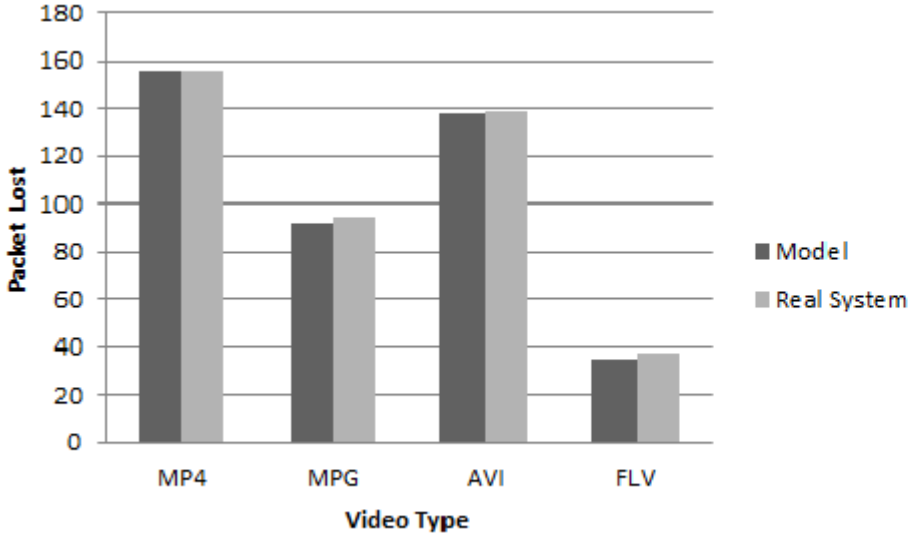
Metrics	Equation
Packets sent (PS)	$TPS * (T_v)$
Packets received (PR)	$TPC * (T_v)$
Packets lost (PL)	$PS - PR$
Throughput (TPC)	$E\{\#PKT\_FLY\} * (1/net\_lat)$
Throughput (TPS)	$E\{\#DATA\} * (1/pkt\_to\_fly)$

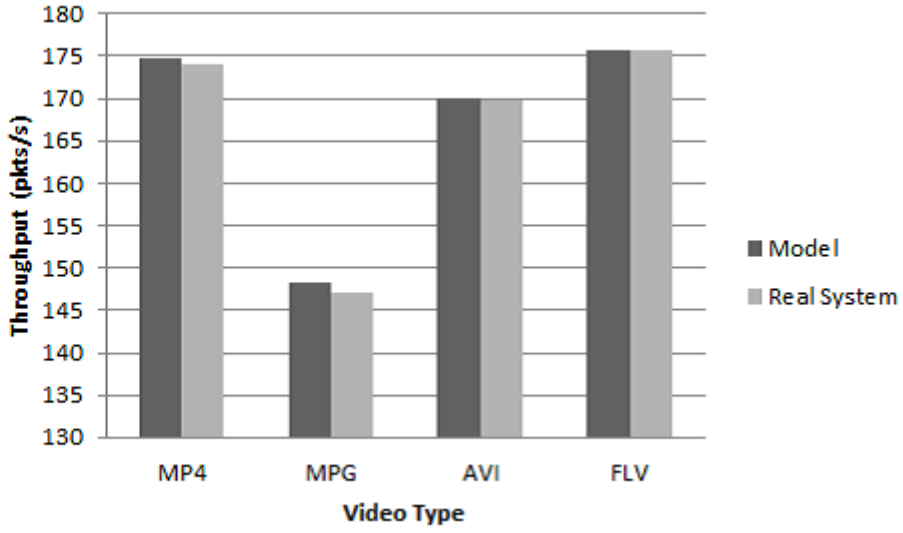
Results

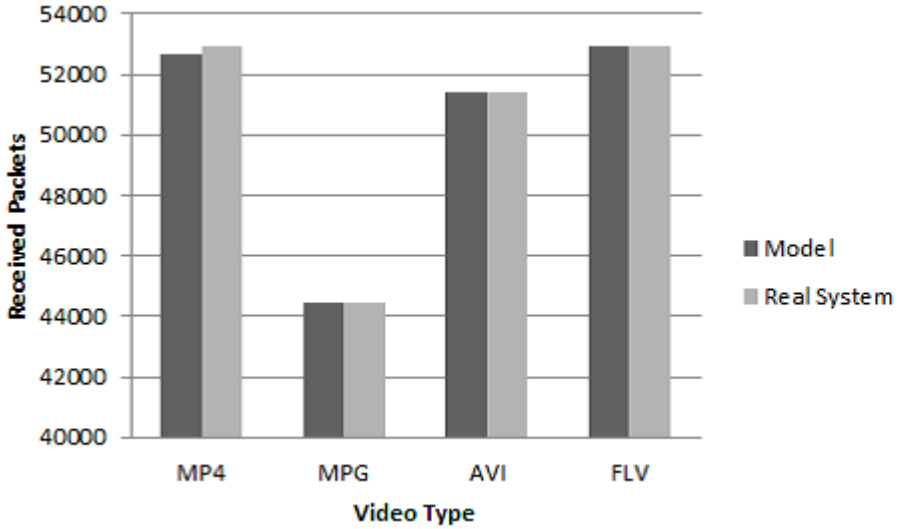
- Performance Model Validation

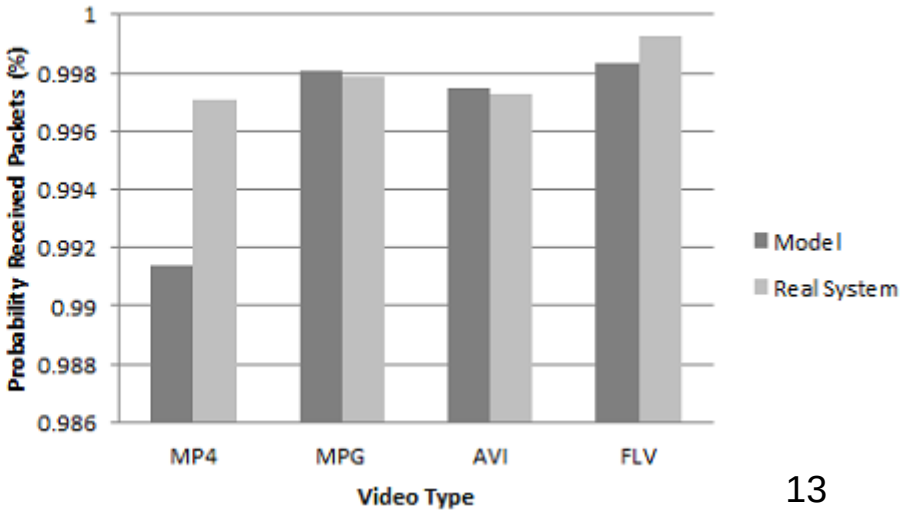
	Video Type	Model (α)	Real System	Confidence interval (via bootstrap)
Packet Loss	MP4	155.66	156.27	$92.93 < \alpha < 229.80$
	MPG	92.49	94.60	$63.63 < \alpha < 124.27$
	AVI	138.20	139.27	$105.13 < \alpha < 174.10$
	FLV	35.32	37.70	$17.67 < \alpha < 63.40$
Packets Received	MP4	52635.76	52938.73	$52613.67 < \alpha < 53000.83$
	MPG	44461.10	44452.40	$44420.33 < \alpha < 44481.67$
	AVI	51437.29	51427.73	$51392.70 < \alpha < 51461.60$
	FLV	52894.98	52946.30	$52818.53 < \alpha < 52966.07$
Throughput (server)	MP4	174.78	174.04	$173.94 < \alpha < 174.90$
	MPG	148.23	147.81	$147.44 < \alpha < 148.30$
	AVI	169.93	169.86	$169.85 < \alpha < 170.09$
	FLV	175.99	175.70	$175.68 < \alpha < 176.31$

Results


180
160
140
120
100
80
60
40
20
0
Packet Lost
MP4
MPG
AVI
FLV
Video Type
Model
Real System


180
175
170
165
160
155
150
145
140
135
130
Throughput (pkts/s)
MP4
MPG
AVI
FLV
Video Type
Model
Real System


54000
52000
50000
48000
46000
44000
42000
40000
Received Packets
MP4
MPG
AVI
FLV
Video Type
Model
Real System


1
0.998
0.996
0.994
0.992
0.99
0.988
0.986
Probability Received Packets (%)
MP4
MPG
AVI
FLV
Video Type
Model
Real System

Case Study

- This section presents a case study to demonstrate the feasibility of adopting the proposed model to evaluate some QoS parameters for different scenarios. This experiment evaluates the packets received by client, lost packets, and throughput in four wireless network technologies: WiFi, 3G (EVDO), 3.5G (HSPA+) and 4G (LTE).

Case Study

- Note that the values presented in [27] are for 100MB file, not specifically for video files, therefore it is necessary to estimate the packet loss ratio for the four studied types of videos.

Technology	Latency (ms)	Loss Rate (%)
4G LTE	77.31	0.13
3.5 HSPA+	115.32	0.14
3G EVDO	348.02	0.27

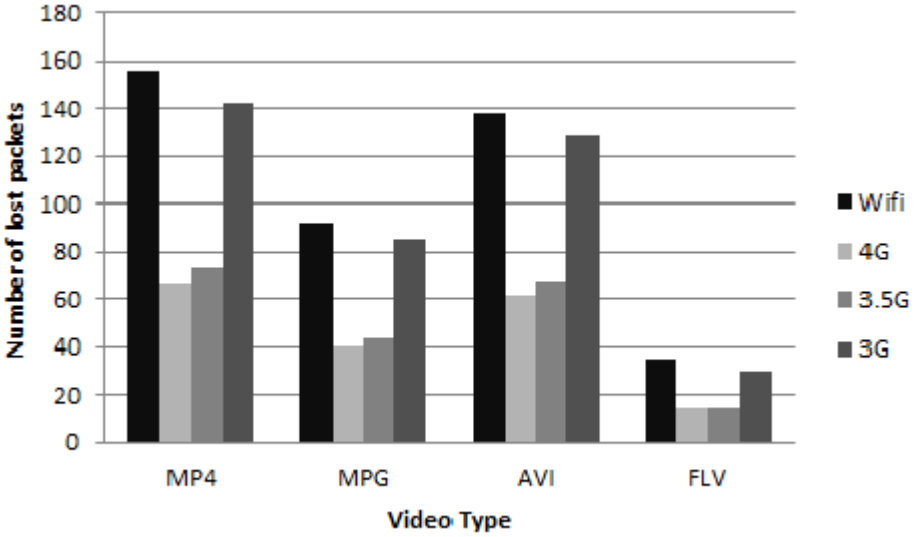
Case Study

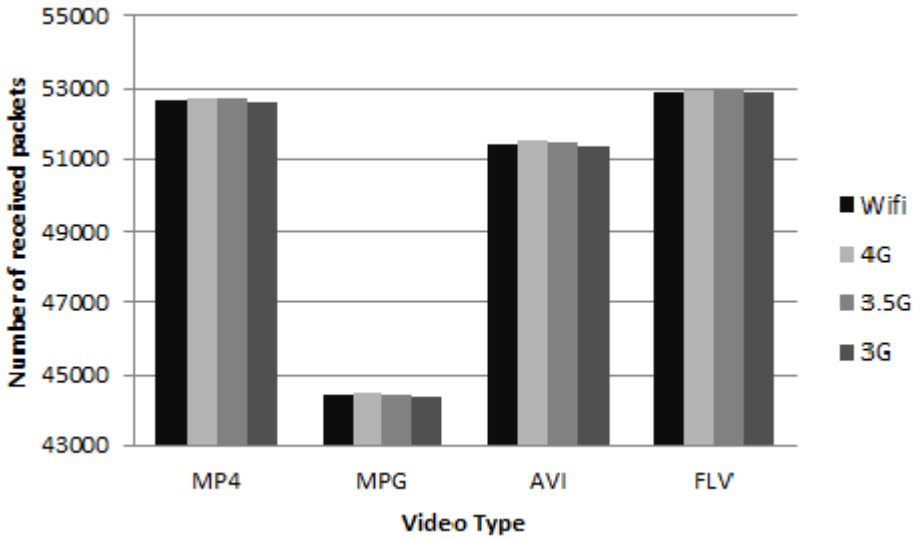
- We considered that the MP4 type has the same loss ratio shown above for each nework type (wifi, 3G, 3.5G, and 4G).
- For other types we used the proportion in relation to the MP4 type, equivalent to the proportion observed in the WIFI network.

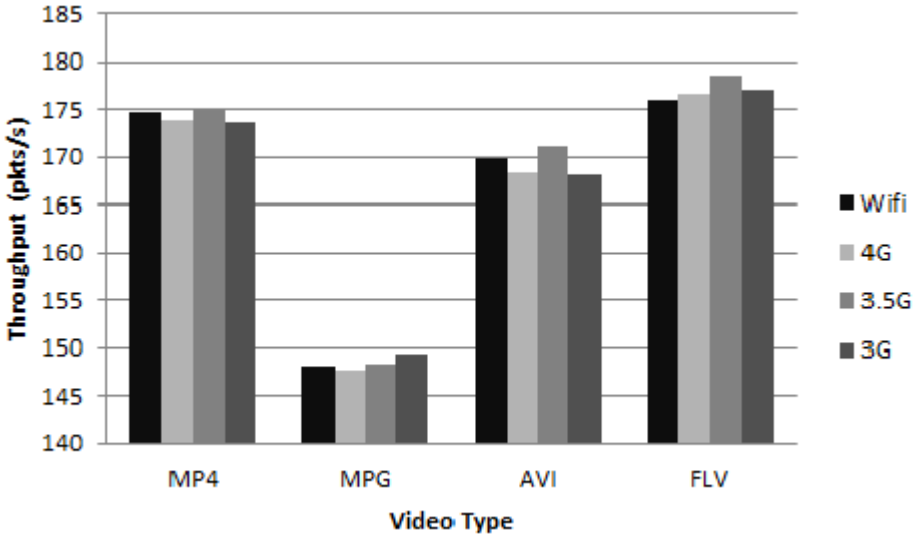
$$P_{3G}^{MPG} = P_{3G} \, x \, \alpha_{MPG}$$

Video Type	P_WiFi (%)	α	P_{3G} (%)	$P_{3.5G}$ (%)	P_{4G} (%)
MP4	0.29	1	0.27	0.14	0.13
MPG	0.21	0.72	0.19	0.10	0.09
AVI	0.27	0.93	0.25	0.13	0.12
FLV	0.07	0.24	0.06	0.03	0.03

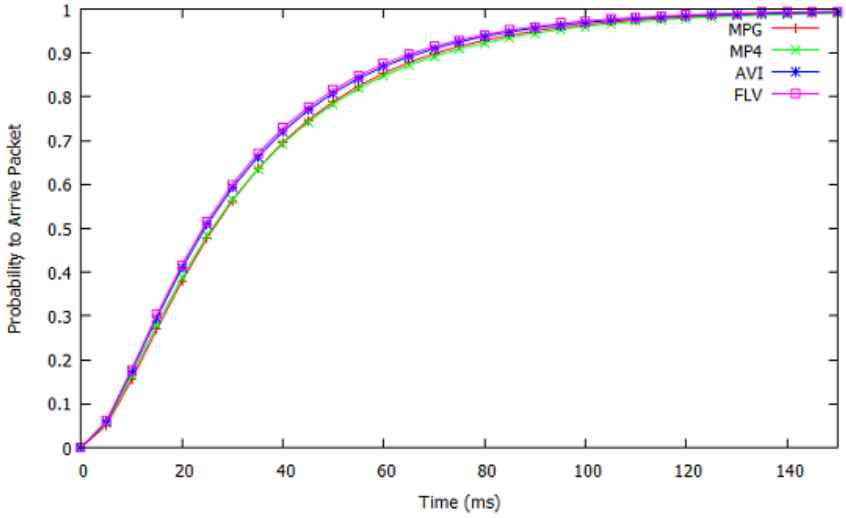
Results


180
160
140
120
100
80
60
40
20
0
Number of lost packets
MP4
MPG
AVI
FLV
Video Type
Wifi
4G
3.5G
3G

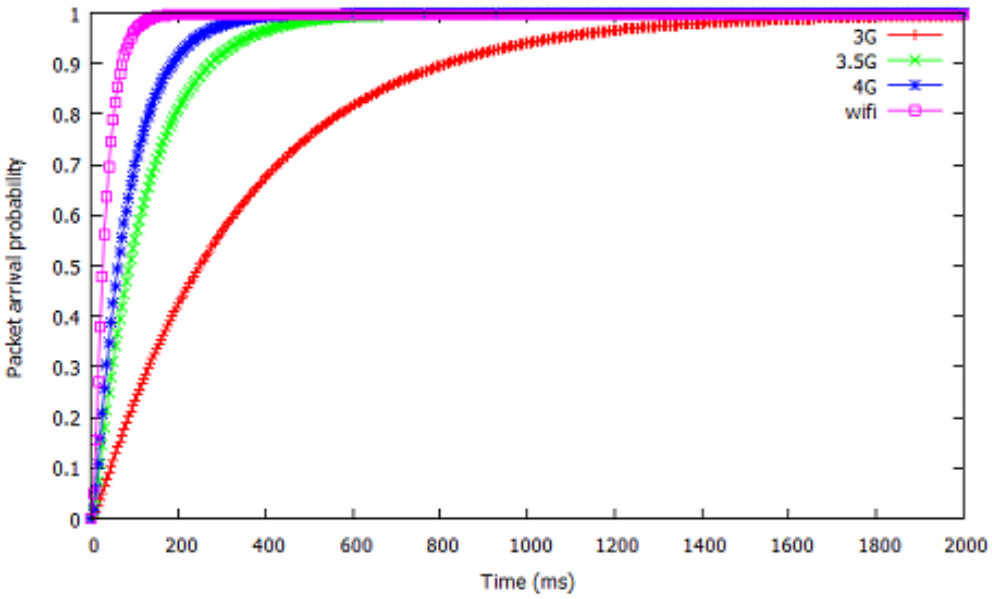

55000
53000
51000
49000
47000
45000
43000
Number of received packets
MP4
MPG
AVI
FLV
Video Type
Wifi
4G
3.5G
3G


185
180
175
170
165
160
155
150
145
140
Throughput (pkts/s)
MP4
MPG
AVI
FLV
Video Type
Wifi
4G
3.5G
3G

Results



Packet arrival probability for each video type in Wifi network



Probability for Each Scenario - used by MP4

Conclusion and Future Works

- Performance model validation to evaluate some metrics of a video streaming service over UDP protocol in a cloud computing environment.

- The proposed model is refined by mean of moment matching approch, which enables accurate representation of non-exponential time distributions.

- As a future work, we intend to analyze other scenarios.

Thanks!

Jamilson Dantas

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